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**Urban Systems Analysis:
A Literature Review**
[Background Paper No. 5]

December, 1974

This report was prepared as background material in the Planning of The North Pickering Planning Area and does not necessarily constitute a recommendation of the North Pickering Project nor approval of the Government of Ontario.

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URBAN SYSTEMS ANALYSIS: A LITERATURE REVIEW

INTRODUCTION

In order to provide the necessary groundwork for developing a working framework for the analysis of the urban system in the Central Ontario Planning Region, empirical studies were reviewed to gain further insights into the city size/function/growth/location correlates as they exist in present day urban systems. The importance of urban systems in the organization and evolution of the "space economy" has been well documented in the literature and emphasized in the applied context of formulating planning strategies and policies (Lithwick, 1970). It should be noted that this review is intended to provide a critical first step towards the operationalization of the research theme of detailing and understanding probable and desirable economic profiles for North Pickering at various stages of its development.

An urban system may be defined in very simplistic terms, as a set of cities along with their hinterlands, which are interrelated or connected in such a way that the efficiency of the overall system tends to be maximized.¹ The inter-relationships between the centres are articulated by flows of information, labour, decision making power, commodities and, by the existence of facilitating conditions such as external and scale economies. These interdependencies in turn determine the spacing, size and economic structure of individual cities within the urban system. Furthermore, the various interdependencies are manifested into: 1) urban flows through the urban hierarchy generated by market orientated activities² leading to a hierarchical dominance structure such as that depicted by the

¹ This maximum efficiency level may never be reached since the social-economic political variables are continuously changing.

² Market-orientated activities in this context refer to those activities which serve the final demand generated within a given urban system.



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Christallerian central place system and; 2) non-hierarchical (lateral or horizontal) inter-urban interaction generated by flows associated with other than market-oriented activities. The first subset of interdependencies is most often associated with central-place tertiary activities (and related market-orientated industrial activities). Notions of geographic size of markets (local, regional and national) are important variables in understanding the various forms of inter-urban interaction.

Empirical research on urban systems is concerned with identifying some type of ordering or systematic variations that may exist as a result of the spatial inter-urban interdependencies. Two main conceptual frameworks have been applied in this type of ordering research. First, central place theory postulates that a hierarchy of urban places exists in the economic landscape. The range and threshold values for various urban activities (tertiary) are manifested in a hierarchical ordering corresponding to some regularity in city size/distance/activity composition differentials. Second, growth pole theory attempts to explain spatial-temporal ordering in terms of spatial transmission of growth determinants. The theory postulates that the level of development or rate of growth at a point in space is some function of distance/and time from a defined growth centre (an urban place experiencing rapid and early growth and a high level of development). Even though hierarchical flows are studied in a growth pole context, the more traditional approach is to analyze the propulsive impact of a growth centre with respect to lateral or contiguous flows (spread and backwash effects) from the pole (core region) to its urban sphere of influence (periphery). Thus, it may be argued that central place studies are concerned with some vertical (hierarchical) ordering whereas

growth pole research also considers horizontal ordering in its approach.

The present review is presented under sub-headings which identify the various research themes offered in the literature, but owing to the nature of the topic, overlap is unavoidable.

STRUCTURAL DIMENSIONS OF URBAN SYSTEMS

City Size and Tertiary Activities

The largest proportion of empirical research in this area has been done by central place analysts and consequently the identification of activity thresholds, range (market areas) and spatial hierarchies has been stressed. Central place literature has been repetitive and speculative with considerable discussion given to the definition of centrality (Marshall, 1969; Biermann, 1973; Davies, 1970; and, Davies, 1967), the classificatory or grouping methods for identifying 'pyramidal hierarchies' (Harvey and Auwerter, 1973; Preston, 1971; and Tarrant, 1968) and the related debate between 'continuous functional relationships' and existence of 'discrete classes' of urban centres (Marshall, 1969). No attempt is made here to expand upon these various notions, instead, findings of city size ordering (continuous or discrete classes) are of primary concern.

In general, central place studies have demonstrated certain relationships between city sizes and tertiary activities (see also, Berry, 1967; Berry, Gardiner and Tenant, 1962; Carter, Stafford and Gilbert, 1970; Forbes, 1972; Kenyon, 1967; Thoman and Yeates, 1966; and, Thomas, 1960). Positive relationships have been found between population and number of functions, between number of establishments and population, between number of establishments by types of activity and population, between number of functional units and population,

and between numbers of functions and establishments.³ It should be pointed out that the above relationships are shown to be curvilinear, indicating that the number of functions increases at a decreasing rate as the population increases.

The studies mentioned above differed somewhat in their findings. However, these differences were in degree rather than in kind. For example, the relationships were stronger in some studies than in others. These differences are attributed to the differing economic base of each study region and to the data sample used (i.e. types of activities, numbers and size frequencies of cities and measures of "centrality" adopted). Similarly, some studies identified a discrete hierarchical ordering of cities (Thoman and Yeates, 1966; and Carol, 1966). This hierarchical ordering has varied according to complexities of functional size, population and economic thresholds as well as to trade area and size, and range (economic reach) which will be reviewed later under hierarchical flows.

Examining the distribution of different activities, Forbes found that those stores which become less frequent in larger metro areas offered a wide line of merchandise (e.g. department stores and appliance stores). The opposite trend was noted for specialty stores. Forbes hypothesized that, 1) the former group consisted of activities where "scale economies are more easily recognized than in specialty stores which cater to a particular, narrowly defined market and where, due to the services offered, scale economies

³ In the present context, the following definitions apply:

- i) function: a type of service activity
 - ii) establishment: a service unit of any type or group functions.
 - iii) functional units: number of units for each function.
- Note: Functional unit differs from establishment in the sense that one establishment may offer two types of functions and therefore contribute one establishment and two functional units to the data inventory.

were hard to come by" (Forbes, 1972, p.21). He then suggested, "There is a threshold below which the market is too small for a specific type of specialty store to be viable. Once the 'mass' of buying power--a function of income and population--reaches a critical point a specific type of specialty store becomes a viable type of function and comes into being. The reaching of thresholds reduces the need for as many generalized types of stores" (Forbes, 1972, p.21).

It was further suggested by Forbes that central place studies should also include the following variables: labour costs, growth, climate, mobility, technology and income distribution. Similarly, Stafford (1963) found that the rankings of functions differed by area, depending on the economic base and population density.

With respect to spatial patterns, Marshall (1969) noted that urban centres with less tertiary functions than expected for given population levels are generally found to be grouped near a large centre in which manufacturing was an important activity, therefore suggesting that these centres are providing a weakly developed dormitory function for the nearby larger towns (see also, C.O.J.P.B., 1973; Kates, Peat, Marwick & Co., 1973; and Russwurm, 1970). On the other hand, urban centres with more tertiary functions than expected are located relatively far from larger urban centres with greater centrality (see also, Thoman and Yeates, 1966; and Hodge, 1966). It is further suggested that these urban centres have hinterlands which are larger and more populated than the norm, enabling them to provide functions which could not be sustained in a centre of equal size but with a smaller hinterland (Marshall, 1969, p.168).

Marshall, comparing the Barrie and Owen Sound urban

systems, also observed that certain functions tended to shift upwards in the hierarchy, thus indicating that a central place hierarchy could adjust to changes in population density by an upward shift of incremental functions rather than an increase in the distances separating centres of equivalent rank. The author also noted that a reverse 'functional leakage' trend was present, leading to the conclusion that "the presence of a particular function in one centre guarantees neither its presence in all centres, nor its absence from all centres with fewer functions" (Marshall, 1969, p.86). The general pattern that emerged was that the order of entry (threshold) of central functions is significantly affected by proximity to a large (metropolitan) centre.

Davies (1967) offers further evidence of deviating patterns. He found that low rank centres had a relatively large functional equipment and that these centres were either peripheral centres or near a higher order centre which have experienced decline in function. Heidenrich (1964) also found that certain places with under-developed business districts (fewer functions and functional units than expected with population levels) were located in an orbit around larger centres. For Ontario, this larger centre competitive effect was evident in Thornbury and Stayner, located near Barrie and Collingwood; and in Bolton, Aurora and Newmarket within the Metro Toronto orbit.

In conclusion, city size/tertiary activity regularities have been identified in a number of urban systems analysis studies. Moreover, considerable attention has been given to the analysis of deviations from this ordering. These deviations in turn, however, have spatial regularities, as

discussed above, of which it appears that interurban competition and metropolitan dominance are the most important factors. The deviations also suggest that the population of an urban centre's hinterland (sphere of influence) must be explicitly considered when analyzing centrality/function correlates. Also, the degree of spatial competition for consumer demand between centres at the same order and of higher orders, will affect the tertiary activity profile of urban centres. This spatial competition, in turn, is a function of distance between centres. Thus, low ordered centres near a first order centre will tend to have a different profile than that of a same order centre located further away.

City Size and Secondary Activities⁴

Ullman and Dacey (1960) proposed a technique, the 'minimum requirements method', for determining a city's basic or excess employment which defines the minimum percentage of a labour force in various sectors of its economy required to maintain the viability of an urban area. They found that as city size increases the minimum employment in the various functions also increases, thus supporting the hypothesis that the larger the city is, the more self-contained it is and the more diversified functions it possesses.

Maxwell (1965), applying the above technique to Canadian cities and recognizing three important characteristics of urban functional structures; 1) the city's dominant function, 2) the city's distinctive function and 3) the city's degree of specialization, was able to arrive at a functional classification of cities. For example, 'Manufacturing I' cities had

⁴ Several of the following studies have combined secondary and tertiary activity data in the analysis. Therefore, some of the comments made here are related to the preceding section.

more than 50% of the basic employment in manufacturing whereas in 'Manufacturing II' centres, the same sector dominated but employed less than 50%. Even though city size/function correlates were not explicitly examined, the study does provide some useful observations on locational factors of the distribution of manufacturing activity. From the findings, a strong heartland-hinterland contrast emerged. It was found that 'Manufacturing I' cities in the heartland were highly specialized due to inter-urban interdependencies whereby cities can rely on other cities for many of their needs. It was also noted that wholesale trade appeared as a distinctive function only in Toronto and Owen Sound (within the C.O.P.R.).*

Marshall (1972) proposed a refined classification of Ontario cities. He found that "manufacturing specialty" centres were strongly concentrated in the Golden Horseshoe and only Toronto emerged as a 'regional service' centre, thus reflecting Toronto's role as a primate metropolis performing a wide variety of services. Cobourg with its military supply depot was classified as an administrative centre and Niagara Falls as miscellaneous because of its scores in Personal Services, Community and Business Services, Transportation Communication and Utilities--only centres in the C.O. P.R. are considered in the present context.

It should be mentioned that Britton (1972) suggested another approach for grouping cities. Using occupational data for Ontario and Quebec cities, he grouped the cities according to similarities of economic functions.

Examining urban occupational composition and its determinants, Mathur (1970) argued that the relationship between city size and 'occupation mix' can only be studied by

* Central Ontario Planning Region

introducing other variables such as industry mix, education and labour force characteristics into the analysis. Through stepwise multiple regression analysis, the above relationship was tested for 211 U.S. centres grouped into four size-classes. The results indicated that only in the largest size class did population have a significant and favourable impact on occupation-mix earnings. One of the major factors for this observed relationship is the fact that large cities attract better educated and skilled persons from smaller cities. Related to this migration is another pattern which indicates that new industries have a tendency to locate in larger urban areas which have a highly skilled labour force and are very accessible to information and innovations; while slow growth, traditional, older industries tend to locate in urban places of all sizes (Thoman and Yeates, 1966).

Two additional comments should be made. First, occupation-mix earnings of cities were dependent variables in the regression analysis and therefore a true test of occupational composition (profile) and city size relationships cannot be evaluated. Mathur in fact discusses his results in terms of diseconomies of scale and city size. Second, many of the independent variables used in the regression are not really independent but instead are related to each other. Therefore, the 'true' importance of population size on occupation mix (indicated by the regression co-efficient) may be buried because of this 'interaction' between the independent variables.

Several empirical studies have been concerned with the relationship between population size and some measure of industrial diversification. Clemente and Sturgis (1971) correlated population and industrial diversification for U.S.

regions and found that the population size, even though the relationship was significant, failed to explain a more theoretically satisfactory level of variation with respect to industrial diversification.

Crowley (1971) using data for Canadian cities, attempted to provide more substantial results for the above relation. His observations are summarized below.

- 1) Only measures of internal specialization (industrial mix within the city) as compared to diversification (mix within the 'system' i.e. a relative measure) appeared to be significantly correlated with city size.
- 2) Labour force yielded higher co-efficients than population as the independent variable.
- 3) Specialization indices decreased from 1951 to 1961 and
- 4) The empirical relationship was, once again, not as strong as the theoretical literature suggests from which Crowley concluded that these cities may be largely independent rather than interdependent. This conclusion is important since it opposes the views presented earlier by Maxwell.

An extensive study on manufacturing activities/city size relations was attempted by Morse, Mather and Swamy (1968). A classification of U.S. industries by city size classes, based on location coefficient measures, was proposed. Briefly, the most footloose industries included food and beverage products, all of which represent consumer orientated (final demand) product industries. Basic metals, machinery and transport equipment had high incidence in cities of 10,000 to 99,999. Heavy chemicals were predominantly non-urban as was textile which also favoured small sized centres. The

location of these two industries, therefore, appear to have been influenced by low wage/skill requirements.

Lomas (1970) tested the relationship between services and manufacturing employment and the centrality of towns by applying simple regression techniques. The results showed a high correlation between employment in the services industries and employment in different manufacturing activities. As in the previous study, all the highly correlated activities tend to be final demand orientated.

In concluding this section, the reviewed studies suggest that city size/secondary activity correlates vary greatly by types of activity. It would appear therefore that market size, strength of forward and backward inter-industry linkages and types of demand services (final vs. intermediate) influence the mobility of various manufacturing activities. The problem of interdependent or independent cities is also related to industry mix (local, regional and national market orientated activities) and strength of external linkages. Finally, as was evidenced in the previous section, the presence of the primate centre, Toronto, has a very strong impact on the economic landscape in Southern Ontario. Once again, inter-city competition between centres of equal and larger sizes for attracting certain types of industries, plays a dominant role in determining the economic profile of urban places.

City Classifications and Urban Dimensions

The use of principal components and factor analysis to reduce a wide array of descriptive data for a set of urban centres to a series of 'representative dimensions' which elucidate the underlying structure of the urban system is becoming increasingly popular as a tool in classification

problems. The rationale behind this approach is that the major components indicate basic similarities between cities and urban systems and that they provide a standardized basis for comparison. Two factor analytic studies which have direct relevance to C.O.P.R. are that of King (1966) and Bunting (1972). Classification of cities is achieved by applying some grouping algorithm to the factor scores for each centre.

Using 1951 and 1961 data and comparing the factor structures for both time periods, Bunting observed the following trends:

- 1) between 1951 and 1961, size proportionate growth occurred only for centres with larger populations whereas for smaller and medium sized places growth rates were highly variable.
- 2) by 1961, a distinctive group (obsolescent centres) of small places emerged from the groupings; this did not occur in the 1951 analysis. Bunting suggested that 'declining forces' increased in strength over the decade and came to the forefront in 1961 resulting in a distinct group of centres aging economically, structurally and demographically.

King observed that a strengthening of the Southern Ontario cluster in the urban-dimensions space, reflected by the groupings in 1951 and 1961, appeared, thus suggesting that there exists a well defined urban sub-system which is relatively homogeneous in terms of the attributes. It should be noted that a number of classifications have been proposed for Ontario cities, with each one differing according to the type of data collected, definitions used, cities considered and the method of factor analysis and grouping algorithm chosen.

URBAN GROWTH CHARACTERISTICS

Golant (1972) with multiple regression techniques, tested the following hypotheses: 1) variations in past

population and economic growth performance are reflected by differences in urban structure (demographic and social, employment and occupational, physical structures and, location and hinterland characteristics), that is, urban growth and urban structure, and; 2) it is possible to isolate growth potentialities from existing structural conditions. In general, measures of proximity to urban populations were found to have a significant and positive effect on population and economic growth.

Hodgson (1972) focussed upon growth characteristics of small centres and used nearest neighbour analysis to demonstrate that urban growth has a significant regional/spatial component. The analysis did show that growth appeared to be a regional phenomenon, being a complex function of the distance between towns. This observation was further tested through multiple regression analysis which showed that 1951 population and accessibility contributed most significantly to the explanation of growth variation.

Barber (1972) approached the problem of identifying growth determinants by grouping Ontario-Quebec cities into (I) growing, (II) unstable and (III) declining centres based on a centre's growth rate relative to the overall mean population growth rate. It was shown that as city size increases, the range and variance of growth rates decreases steadily. Also, differential accessibility and employment mix particularly in manufacturing emerged as the key growth determinants. It is worth noting that the importance of employment mix as a growth determinant was not supported by Golant's analysis.

Barber and Britton (1971) give supporting evidence for Golant's finding. Based on Britton's results, a discrimi-

natory analysis failed to define satisfactory city groupings exhibiting similar rates of change. Several influencing factors attributing to this failure were suggested by the authors: 1. interdependence of city growth rates 2. cross commuting leading to further interdependence as well as to imperfect statistical correspondence and 3. the 'field effect' of Metro Toronto (as well as Montreal).

Siegel and Woodyard (1971) tested whether an urban centre's position in the urban hierarchy will effect its growth experience. Using cross-sectional data based on telephone calls, the regression analysis indicated that a) for satellite cities: 1. supply (measured by growth in municipal expenditures '56-'59) and demand (growth in manufacturing employment '51-'56) factors played an equal role in generating growth, (measured by in-migration levels); 2. accessibility (driving time to nearest higher ordered centre) was a significant variable only when it interacted with manufacturing growth; b) for independent cities: 1) accessibility was significant whereas municipal expenditure was not.

Crowley (1971) analyzing the growth characteristics of 46 Canadian cities, identified three urban growth components. These are as follows:

1. growth effect: component attributable to growth rates of industries for a particular city compared to the all city average;

2. composition effect: component of growth accounted for by the industrial composition (i.e. the type of industry) characterizing a city and;

3. interaction effect: residual component similar in nature to the properties assigned to specialization coefficients

or location quotients (i.e. the city's industry composition) may be comprised of mostly fast-growing industries, in which case the residual component is positive.

The study also included an analysis of specialization measures and city size. The main conclusions are summarized below.

1. Cities do not have labour forces concentrated in those industries which are growing relatively most rapidly. The growth effect was generally more important in explaining change than was the composition effect. For Ontario cities, the growth effect was found to be generally positive (positive for all centres in the C.O.P.R.) whether the city grew slower or faster than other cities. "Thus if an Ontario city grows less rapidly than 'average', this can be usually attributed to an adverse industrial structure" (Crowley 1971, p.29).

2. Coefficients of rank correlation between city size and internal specialization and relative specialization (location quotient) showed no strong relationship. The weak city size - location quotient suggested to Crowley that cities may be largely independent. This finding is further expanded upon in the 1972 study in which Hartwick and Crowley concluded the urban complexes centering on major Canadian cities are not internally integrated in the sense of producing complementary goods.

3. Labour force is becoming more dispersed. This is reflected by decreases in specialization indices between 1951 and 1961.

Ambrose (1970) offers further insight into urban employment growth patterns. Between 1951 and 1961, he noted that problems of differential growth in Southern Ontario did

exist. Besides Metro Toronto and Hamilton, rapid growth during this decade was experienced by Kitchener/Waterloo/Guelph complex, due to its diversity in manufacturing activities, by Sarnia, because of expansion in the chemicals groups, and by Barrie, due to growth in metal manufacturing, federal administration and retailing groups. In view of export base theory, Ambrose suggests two interesting hypotheses. First, growth in centres may not be largely dependent on growth in basic activities. Second, the employment multiplier notion may depend on the stage of the growth cycle, as full service provision lags behind new manufacturing expansion. Using regression techniques, Ambrose further found that, for Canada, the medium and small sized centres have shown a low rate of tertiary increase per unit secondary increase and that this rate fluctuated considerably from centre to centre. In the larger cities, the tertiary sector growth has been much more rapid than manufacturing growth.

Comparing sectoral growth trends with urban growth trends, Ambrose found that "town consistent" groups, i.e. groups whose growth depended largely on change in local demand population such as retail, personal services and religion were differentiated from those that were "town-independent" i.e. groups producing for regional, national or international market, such as transport equipment and knitting mills, which showed considerable independence of total local trends. The author concluded from his analysis that high growth rates seem to be associated, not so much with the particular regional location or size class of centres, but rather with the base year sectoral balance (i.e. manufacturing mix 1951). Thus, Ambrose's study seems to support Crowley's

growth/composition components analysis. Lister (1966), on the other hand, observed by plotting percentage growth rates (1901-11, 1931-41, 1951-61) against city size that 1) growth characteristics varied with size of centre, smaller centres experiencing the greatest fluctuation; 2) proximity to a major centre was an important determinant; and 3) relative size to other cities (competitive advantage) was a third factor influencing local growth rates. Through a simulation model, Lister also found that, in the four stage growth process model derived from the simulation, central place forces became operative only during the third stage which was followed by a 'clustering stage' whereby growth in centres in close proximity to metropolitan areas occurred. In other words, metropolitan 'spread forces' dominated over central place forces.

Locational (spatial) patterns of growth were also observed by Semple (1966) in his trend surface analysis for small centres in Southern Ontario. By separating spatial trends of growth, the trends surface technique identified four peaks in the development surface, Toronto (32.7% of explained variance) Prescott, Guelph and Arnprior and two troughs at Bobcaygeon and Markdale.

Other 'growth pole'-type of studies outside of the Ontario context, presented similar findings. Hart and Salisbury (1965) for example, observed that variations in population change were significantly explained by proximity to large centres and little by population size. The same pattern was observed by Hodge in the Canadian plains area. Some further studies suggest that the spatial extent of spread effects have been effectively confined to the commuting

hinterlands of major urban centres. (Moseley, 1973; and Nichols, 1969).

In summary, there appears to be somewhat conflicting evidence on what factors determine a centre's rate of growth. Three main variables have been suggested: relative size of centre (in contrast to absolute size), distance from growth pole (metropolitan centre) and industry-mix. It would appear that urban growth is a complex function of these three variables.

SPATIAL FLOWS AND INTERACTION IN URBAN SYSTEMS

Empirical research on spatial flows may be grouped into the following main areas of inquiry:

1) identification of functional/nodal regions or urban spheres of influence: in central place studies, such an analysis has been mainly concerned with the identification of market areas (i.e. economic range or reach) associated with urban centres, in each hierarchical order. As such, consumer shopping behaviour or flows have been stressed. From the analysis of consumer behaviour, a hierarchical structure of centres, may be identified with each order corresponding to a particular market area which in turn, leads to a 'nesting pattern' of 'overlapping' of increasing order of areas (see Ray, 1968).

Urban spheres of influence have also been derived indirectly through the use of gravity models applying notions of potential interaction (see, Huff, 1973; Illeris, 1967; and Berry, 1967).

2) testing growth pole notions of spread and backwash effects: growth pole research has been largely concerned with the study of spatial origin, transmission and incidence

of growth impulses (spread and backwash effects). Whereas central place theory places more stress on the shopping/consumer behaviour from the hinterland to the central place, growth pole theory deals with a greater range of spatial flows not only to but also originating from an urban centre or growth point, such as flows of factors of production, technology and innovation, control of decision and commodity flows.

The above two areas of inquiry may be grouped together as studies of contiguous or lateral flows between a centre and its hinterland. Within the central place framework, these flows have often been referred to as 'space-preferences' consumer purchases (Rushton, 1971) and to 'gradients of urban influence' in a growth pole context (Berry, 1969). These approaches are not distinct from each other but instead are quite interrelated as is shown by Berry in his study of the Upper Great Lakes Region in which several central place notions have been applied to identify centres of greatest growth potential. Besides 'horizontal' (continuous) flows, 'vertical' (discontinuous) flows also are important components of spatial interaction.

3) examination of vertical/hierarchical flows: it has been argued that the urban system is an important channel for the transmission of developmental determinant or an efficient mechanism for distribution services and tertiary activity. Inter-urban interaction provides the main research theme in studies of vertical flows. Work on diffusion of innovations represents such approaches. Inter-urban relations have also been analyzed for the purpose of identifying inter-related or integrated urban (sub) systems. Several statistical

techniques have been proposed in this context such as regression analysis in which correlation coefficients between urban-centres reflect similarities in for example, business cyclical behaviour (Casetti, King and Jeffrey, 1969), graph and network analysis (Medvedkov, 1968) direct and indirect inter-urban linkages (Nystuen and Dacey, 1961) and hierarchical clustering algorithms (Harvey and Autwerter, 1972).

The empirical literature on spatial flows is abundant and a thorough review of these studies is beyond the purpose of this report. Therefore, the present review will be restricted to studies directly related to the Central Ontario situation with occasional reference to other extra-regional studies for purposes of completeness.

Consumer Shopping Behaviour and Hierarchical (Vertical) Flows

Marshall (1972) has attempted to classify centres in Southern Ontario through the analysis of shopping behaviour. He found that Guelph residents habitually shopped in Kitchener while Guelph itself was a minor shopping centre. Similar patterns were found for Niagara Falls and Welland which are overshadowed by St. Catharines. It was also noted that Oakville functions as a dormitory town for Toronto and Galt as a satellite city of Kitchener. In the same study, Marshall delimited trade area boundaries on the basis of circulation records of daily newspapers and of telephone calls. Similarly, Simmons (1972) used telephone calls, airline traffic and commodity flow data, as measures of centrality, to identify different orders of centres. The results reveal a high degree of integration within the Ontario sub-system, characterized by Toronto's overall dominance. Preston (1971) also found a relatively strong association between exported daily newspapers and centrality.

Provincial Concentration

A large proportion of local studies on spatial flows has been concerned with the migration or location patterns of manufacturing plants in Southern Ontario. In general, two dominant simultaneous trends appear to be operating; 1) at the Provincial level, increasing concentration centred on the Toronto metro area, and 2) at the metropolitan level, an opposite decentralizing flow. These two flows are examined below.

In a well known study, the notion of 'economic shadow' was used to measure the accessibility of urban places to finance capital and entrepreneurship (Ray, 1965). The 'economic shadow' model consists of two important concepts: 1) "branch plants tend to be located in the sector lying between the head office [foreign] and the primary market centre within a region;" this tendency was identified as sectoral affinity and 2) "industrial interactance between a part of the region and a city beyond that region becomes an intervening opportunity" and therefore "an economic shadow is cast over the area lying between the spatial sector linking a head office to the primary regional market centre". Given this conceptual framework, Ray argued that urban growth is thus dependent on the city's location in or out of the economic shadow which in turn determines the ability of an urban centre to attract foreign investment. Thus urban growth is expected to concentrate along urban corridors.

Further supporting evidence is given by Collins (1972) and Spelt (1973) who observed that foreign owned plants favoured locations within the Metropolitan Toronto region. Foreign owned industries, Spelt argued, being less familiar with the region, gravitate strongly to the metropolitan centre.

On the other hand, domestic-owned new establishments show little reluctance to select locations outside the Metro Region. It is further suggested that the need for easy contact with parent plants, as well as uncertainty about market conditions, has also strengthened decisions to locate in Toronto with its airport facilities and its role as a political and financial centre (Ray, 1965).

Collins (1972) also noted a centralization trend operating in large part within a 50-mile radius of Toronto for both foreign-owned and domestic-owned plants. For example, 80% of the plants relocating in Toronto originated within this 50-mile radius. These industries were, in general, small-sized electrical products and printing industries. Spelt also noted that centralization (or concentration) was stronger for establishments than for employment which resulted in the characteristic 'mini-establishment' mix in Metro Toronto. It was also found by both Collins and Spelt that firms moving out from Toronto tended to be small to medium sized firms but after relocation their employment usually tended to increase.

Metropolitan Decentralization

Up to now, only the migration of new plants (extra-regional origin) which have partly accounted for differential urban growth and for the concentration of manufacturing activities in Ontario as a whole has been analyzed. Two other variables are also important growth determinants: 1) birth/death differentials, and 2) relocation of domestic firms (Collins, 1972).

The effect of birth/death differentials, even though it is not an element of spatial flows, is an important input for understanding urban growth dynamics. During the 1961-65

period, the death rate for Toronto was 0.2% higher than the birth rate but only 22 of the 300 establishments lost were due to death which suggests that Toronto's loss may be attributed to the migration process. In the suburbs, natural increases accounted for 63% of the gain, thus indicating that suburbs not only function as receptors but also as generators for new industries. Outside the Metro periphery, only Waterloo and Barrie were strongly influenced by spillover effects from Toronto. Also, only Burlington, a suburb of Toronto and Hamilton, and Oakville, a satellite of Metro Toronto, experienced birth rates noticeably higher than the provincial average.

Collins also found that the largest component of change for Ontario as a whole, involved plant relocation from Toronto to its suburbs (i.e. suburbanization), whereas for other C.M.A.'s the process was less well defined. In the former context, the author observed that the most mobile industries were machinery and furniture and fixture plants.

Evidence of suburbanization has been documented in two earlier studies by Kerr and Spelt (1958 and 1960). They found that, while Toronto's share in manufacturing employment declined from 85% in 1950 to 67% in 1960, only the new suburbs of Scarborough, Etobicoke, East York, North York and York experienced substantial increases, whereas older suburbs have remained stationary. To explain this process, the following factors were suggested by the authors⁵: 1) availability of more highly skilled labour which tended to reside in the suburbs; 2) strong associations with old location; 3) high land costs in central city and restriction on expansions; and 4)

⁵ A good general discussion of relocation trends of industries is provided by Stanback and Knight (1970).

available transportation facilities. It should be noted that metal and machinery industries as well as textile mills, especially in York, were the main participators in this suburbanization process.

Decentralization, as Collins observed, occurred mainly within a 50 mile radius of downtown Toronto, e.g. 90% of the decentralizing plants, which were most typified by metal fabricating and miscellaneous industries, relocated within this range. Also, inter-suburban relocation indicated that Etobicoke, Scarborough and North York were the main reception areas at the expense of older adjacent suburbs. Metal fabricating and miscellaneous industries accounted for the largest proportion of these relocating firms.

In summary, the general patterns emerging from the studies reviewed indicate increasing concentration on the Provincial spatial level and suburbanization within the Metro area thus leading towards the development of an 'industrial doughnut' around the traditional centre of manufacturing activity in the city of Toronto. Suburbanization and concentration processes are intensified by differential birth/death rates, location behaviour of foreign-owned branch plants, and relocation of industries into the suburbs thus 'hollowing out' the centre of the doughnut.

Decentralization of Tertiary Activities

The above studies have been exclusively concerned with spatial flows of manufacturing activities. However, evidence on decentralization trends (from Metro region) has also been documented in relation to tertiary activities. Such analyses may be more important within an urban growth context since, as Ambrose (1970) observed, it is the tertiary sector which has experienced the greatest increase in employment in recent years.

One study which examined location trends of services is that of Schiller (1971) on the London Metropolitan area. Distribution patterns of specialist services (car agents, hotels and restaurants, antique shops, boutiques and Diners Club shops) were compared for the Outer Metropolitan (London) area and the East Midlands area through regression analysis. The findings showed that the specialists services in the O.M.A. were less centrally located than suggested by central place theory. Two polarization location trends of high threshold specialist services were observed:

1. decentralization to non-central/rural locations or to high class suburbs and small residential towns. High income, car ownership, population dispersal, congestion and high rent at the C.B.D. and the fact that these services are not heavily dependent on multi-purpose trips accounted for this trend;
2. centralization towards the C.B.D. of certain activities such as restaurants and motels which are dependent upon public transport-based commuters, tourists and distant visitors. Schiller concluded that the metropolitan C.B.D. serves not only its own hinterland but also a wider international system.

Another component of this metropolitan decentralization trend which has received some attention is that of office movement. Hall (1972) attempted to estimate volume of office movement from Central London during the 1963-1969 period. It should be noted, however, that these office movements have been largely the result of direct planning policy. Hall observed however, that 'few of the benefits of office decentralization accrue outside the South East' and that over

half the jobs estimated to have moved out of Central London remained in Greater London; with 13 percent moving more than 80 miles (almost half were Government moves.) The important variable of this distribution, suggested by Hall, was in the structure of office location costs. For location of a few miles from Central London, substantial savings in terms of rent and wages were achieved but for more distant location, even though these savings were greater, they were marginally diminishing.

Metropolitan dispersion has also been observed in several American studies. Berry (1967) observed that this dispersion is most evident in population redistribution with a corresponding pattern of net decline of retail stores at the SMSA centre and net growth in the periphery. In a recent article on decentralization trends around SMSA's, it was suggested that:

"Gradients of distance-accretion are now beginning to replace those of core-centred distance-decay within the larger megalopolitan complexes as persons of greater wealth and leisure seek home and work among the more remote environment-- In consequence-- the multinode, multiconnection system is the rule, with the traditional multifunctional core simply a specialized one among many. It is the spontaneous creation of new communities, the flows that respond to new transportation activities, the waves emanating from new industrial and retail growth centres, the mutually repulsive interactions of antagonistic social groups, the reverse commuting resulting as employment decentralizes, a variety of other facets of social dynamics that today combine and constitute the new urban systems in America". (Berry and Cohen, 1973, p. 454)

Berry (1967) further suggested that shopping centres no longer dominate an immediate, exclusive market area but instead several centres serve the same community of interest area. As a result, in order for centres to compete with the same and higher ordered centres, locational specialization introducing various economies have become necessary. In

short, centres within expanding metropolitan regions are influenced by new locational forces and forms of interdependence, thus, the classical patterns of central-place hierarchy break down and are replaced by business patterns characteristically internal to the centres.

Further evidence has been offered in a study by Kain (1967) for SMSA's. He showed that suburban rings grew faster than central cities with wholesaling employment exhibiting the greatest growth followed by retailing and manufacturing in order of importance. Absolute changes in employment showed the same patterns but with manufacturing leading the way and retailing, wholesaling and services following.

In the Ontario context, few studies on decentralization processes, besides industrial migration, have been made. Spelt (1973) noted that a great deal of decentralization of commercial establishments has taken place, especially with the trend towards major shopping concentrations in the suburban areas. It was also noted that Toronto C.B.D. is accounting for a decreasing volume of retail sales in Metro Toronto. Similar changes, but to a far lesser extent, occurred in the pattern of office concentration. Unfortunately, Spelt concentrated on intra-metropolitan movement and thus little evidence is offered for extra-metropolitan decentralization processes.

In conclusion, it has been shown that tertiary activities are becoming more decentralized due partly to direct planning policy and the creation of new communities in the suburbs. It has also been indicated that new locational forces and forms of interdependence are influencing the classical patterns of central-place structure.

SUMMARY AND CONCLUSIONS

In general, the classification studies reviewed in this paper indicate two functional aspects of the "urban system" in Southern Ontario. One, a large metropolitan centre is surrounded by small-sized, service deficient centres specializing in manufacturing activities. Two, large-sized, diversified centres are located outside Metro Toronto's urban sphere of influence. These aspects seem to suggest that city size alone does not determine the functional role of a centre. Briefly, the deficiency in service activities is related to proximity to Metro, increased mobility of both consumers and labour force, and the specialized economic base of small urban centres.

It should be noted that empirical studies are often too aggregative, both in spatial scale and in data collection, to be of any direct use in the regional and urban planning context. Furthermore, studies have been cross-sectional and static in nature and have ignored the dynamic aspects which are so important to today's urban economics. Most studies, therefore, stop short of useful forecasting.

With respect to North Pickering, the important issue is what does the literature offer in terms of North Pickering's role in the regional planning design as proposed in the TCR Concept and in the current work of the COLUC Task Force.

Two questions are relevant in this context:

1. What effect will the urban system have on North Pickering in terms of its function and structural organization? and;
2. Conversely, what impact will a new town have on the remaining urban system?

Two problems have been defined in the work programme:

1) the identification of 'probable' economic profiles for the new town at various stages of growth; and 2) identification of 'desirable' economic profiles. The first problem is concerned with identifying systems-induced dimensions in reference to city size and location attributes. In other words, given free or spontaneous market forces, what structural/growth characteristics are to be expected given the theoretical concepts and empirical evidence for the new town? In contrast, the second analytical problem involves an incorporation in the plan design and therefore, possibly attempting to modify 'free' market forces to achieve preferred objectives. In short, the identification of probable profiles is related to the former question of urban system impact on North Pickering whereas identification of desirable profiles is more related to the second question, that is, impact of the new town on the rest of the urban system. Empirical findings which offer some insight into the two analytical problems defined above are discussed below.

With respect to the probable profiles for North Pickering two important conditions are self-evident in this identification task. First, predicting probable economic profiles for any urban centre must be done within a wider regional urban system which implies that, second, the analysis must be made within a well defined and integrated urban system in which all centres are influenced by the forces operating within the system. The identification of probable economic profiles can only be achieved if these two conditions are met. Since the Project's work plan is centred on the COPR, it appears that this requisite is not violated.

Throughout this review, reference was continually made to the forces operating within the system and it has been suggested that these forces may be either hierarchical or lateral/non-hierarchical. In both cases, the concern was with systems-induced properties; hierarchical forces expressed as city size/urban activity/market area regularities and lateral flows/accessibility/growth regularities. It has also been argued that lateral flows tend to act as 'deviation forces' distorting the central place hierarchical structure into either a metropolitan primacy or a development axis spatial form. However, hierarchical/primacy/axis spatial forms are all systems induced.

Studies examining city-size characteristics have shown that some activities will not appear in cities until certain population thresholds are met. It has also been found that considerable variation in city size relations occurs within industry groups thus indicating that any empirical testing of size regularities requires disaggregated data.

In the Central Ontario Region, it is the non-hierarchical forces which appear to have the greatest influence on economic profiles of urban centres. In this case, there are other variables such as location and accessibility in addition to size which influence the economic structure of centres. For North Pickering, an identification of probable profiles requires an analysis of the forces operating within the system as they relate, in particular, to the metropolitan primacy or dominance effect.

"Spatial flows" studies have shown that spillover processes do operate in the Southern Ontario "urban system". Briefly, these spillover processes have resulted from spatial constraints in Metro Toronto, increasing production costs in terms of land

rent, transport costs, wage rates, urban diseconomies, and increased mobility of both factors of production and production units.

Some local market and final demand orientated activities are found throughout the "urban system". Manufacturing has become more footloose because of improved technology and the mobility of the labour force. However, agglomeration economies and interindustry linkages have constrained the spatial extent of industrial spillover. This agglomeration constraint does not appear to be a disadvantage for North Pickering. Because of its proximity to Metro as well as to the lakeshore urbanized zone, the new town will be able to participate in common agglomeration economies. Therefore, given the trend of industries being more 'footloose' and given the mobility of labour force, the growth potential and probable economic profile of North Pickering will depend on its comparative and competitive advantages in relation to other centres. The advantages of the new town will not only depend on its city size but also on the availability of urban services, costs of infrastructure and particularly, on its available amenities (residential, cultural, educational, recreational and environmental qualities).

Decentralization of tertiary activities has also been observed in recent years and such a trend seems to suggest that metropolitan centres are increasingly serving national and international markets and becoming less important as regional centres. This 'role transition' may also be necessary since Metro centres have become so large that consumers and employees now find it an inconvenience (in reference 'time' costs of travelling) to shop or commute to the metropolitan

centre. This argument is purely speculative since empirical work on this topic is practically non-existent. The industrial sector has already experienced the decentralization trend and the services sector is presently in the early stage of this process. With respect to the services sector, this trend suggests great possibilities for North Pickering. However, the materialization of these possibilities will depend on the city-size, infrastructure and amenities of North Pickering.

The most difficult research task involves the definition of preferences and criteria by which 'desirable' profiles may be assessed. Any suggested strategy must include the preferred status and role of North Pickering as expressed to date, and the ability to distinguish and identify 'desirable' activities from 'probable' activities.

It should be mentioned that several analytical problems are involved in this part of the research. For example, no city in the Metro area is available for comparison which may facilitate the identification of both 'probable' and 'desirable' profiles. Also, even if a comparative base is possible, there is the unavoidable problem related to the fact that no two cities are alike. In addition, few empirical studies have been done in the study area and these studies have offered little evidence of any consistent regularities.

If North Pickering can be visually placed in the urban system as it exists today, undoubtedly, the new town would function as a low order centre because of its proximity to Toronto. If Toronto, on the other hand, is undergoing or about to undergo a 'functional role transition' phase, North Pickering

as a sub-regional centre may be a feasible concept. The important thing is that the dispersion of higher order activities be directed towards North Pickering and Oshawa and not towards Metro Toronto's suburbs. This implies that North Pickering may be able to tap the market in the Metro area. Studies reviewed in this report, have indicated that people are increasingly becoming more outward looking. What this suggests is that Metro Toronto's regional sphere of influence will decrease over time. This decrease is compensated by a corresponding increase in peripheral centres. The ability of a peripheral centre to attract regional functions will depend on its competitiveness with other centres. Urban amenities may play a strategic role in this context. Such a trend is not improbable, particularly if efficient extra-Metro transportation is available.

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